PROJECT DATA

Electrodes International, Inc. (formerly MER Corporation) 01GO11061

An Insoluble Titanium-Lead Anode for Sulfate Electrolytes

Recipient:	Electrodes International, Inc.	Instrument Number:	DE-FG36-01GO11061
Recipient Project Director:	Dr. Alla Ferdman 847.464.0785 190 Old Oak drive Buffalo Grove, IL. 60089	CPS Number:	1376
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Recipient Type:	For Profit Organization	GO Contract Specialist:	Melissa Wise 303.275.4907
Subcontractor(s):		B&R Number(s):	ED1906020
		PES Number(s):	00-2045 / 01-2361
EERE Program:	Industrial Technologies	State Congressional District	IL - 10

PROJECT SCOPE: The goal of the project is to confirm bench scale testing through successful scale-up of insoluble titanium-lead anodes for electrolytic production of copper and manganese dioxide and to optimize the fabrication technology for industrial production. Technical and economic evaluation of testing results will allow further optimization of the anode composition and structure. The novel anode is expected to reduce energy consumption 25% and CO_2 emissions by 235,000 tons per year.

FINANCIAL ASSISTANCE

Approved DOE Budget	$196,384	Approved DOE Share	$196,384
Obligated DOE Funds	$196,384	Cost Share	$36,132
Remaining Obligation	$0		
Unpaid Balance	$40,000	**TOTAL PROJECT**	**$232,516**

Project Period: 8/30/01 - 8/30/04

TECHNICAL PERFORMANCE
DE-FG36-01GO11061
Electrodes International
An Insoluble Titanium-Lead Anode for Sulfate Electrolytes

PROJECT SYNOPSIS

One objective of this project includes confirmation of prior bench-scale testing of the proposed technology. This will be done through scale-up to test prototypes of titanium-lead anodes for electrolytic production of copper and manganese dioxide. A second objective is to optimize the fabrication technology for industrial production. Efforts will be directed to develop insoluble titanium-lead anodes for industrial electrowinning of copper and electrolytic manganese dioxide (EMD) production with longer life, higher mechanical strength, dimensional stability and uniformity, improved operability and higher quality of the product. Technical and economic evaluations of the test results will allow further optimization of the anode composition and structure, thereby realizing the largest energy impact and economic advantage. These evaluations will enable putting the new anodes into commercial production consistent with extensive market demands. The anode being developed is expected to reduce energy consumption by 25% and CO_2 emissions by 235,000 tons per year.

SUMMARY OF TECHNICAL PROGRESS

Optimization of technology for manufacturing of titanium-lead anode prototypes has been completed. Composition of the titanium-lead materials has been optimized based on the investigation of structural, mechanical, and electrochemical properties. From the tensile test data analysis, a conclusion has been made that the titanium-lead composites, containing up to 33% Pb, have sufficient ultimate tensile strength to be used as anode materials. The titanium-lead anode prototypes, having 20-33% Pb, have been manufactured for electrochemical testing in metal electrowinning conditions at Drexel University and for bench-top testing in industrial copper electrowinning conditions at Phelps Dodge Mining Company. Power consumption, deposit quality, and weight loss of the titanium-lead anode materials have been studied and compared to the data for the conventional lead alloy anodes. The results of the bench-top testing have been found to be favorable. A decision has been made to continue the testing on a larger scale.

Mini-pilot cell titanium-lead anodes of flat design (1100mm x 240mm x 5mm) have been fabricated for further tests. Engineering calculations and process optimization have been conducted to develop an alternative cylindrical design of the titanium-lead mini-pilot cell anode for copper electrowinning. In copper electrowinning conditions, the titanium-lead anodes operate at the same voltage as the conventional lead alloy anodes. It is anticipated that the titanium-lead anodes would have a lifetime of about ten years versus five years for the conventional lead alloy anodes.

The long-term testing of the full-size cylindrical titanium-lead anode in a commercial copper electrowinning cell is progressing. The cost/benefit analysis for the copper electrowinning titanium-lead anodes is being continued. If the pilot test results are satisfactory and the economics are attractive, additional commercial anodes having optimized design and process will be fabricated and the tests will be expanded.

SUMMARY OF PLANNED WORK

The phase one long-term pilot testing of the full-size titanium-lead anode in a copper production tankhouse at Phelps Dodge will be continued. Anode performance data will be collected and analyzed. Metallographic and chemical analysis of the post-test anode will be conducted, and the results will be compared to the pre-test anode analysis.

If the full-size anode performs successfully, additional commercial anodes having optimal design and process will be manufactured for phase two expanded testing. Efforts will be made to minimize the anode cost. The cost/benefit analysis will continue.

PROJECT ANALYSIS

The project is making substantial progress in accomplishing the proposed scope and is expected to finish by the current end date of 08/30/04. Spending has been fairly consistent throughout the project, and no significant cost overruns are anticipated. Long-term testing of the titanium-lead anode in a commercial electrowinning cell is still underway. The results of which remain to be seen.

ACTION REQUIRED BY DOE HEADQUARTERS

No action is required from DOE Headquarters at this time.

STATEMENT OF WORK
DE-FG36-01GO11061
Electrodes International, Inc.
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Detailed Task Description

Task 2. Optimization of Technology

The purpose of this task is to optimize the fabrication technology for Ti-Pb anodes. The investigations will be performed to establish interconnections between structure of the anodes and their electrochemical behavior, erosion rate, mechanical properties and product quality. Optimized compositions and structures will be used for the prototype fabrication and pilot plant testing.
Activities will include:

- Optimization of compaction conditions for porous titanium skeletons.
- Optimization of conditions for infiltration of Ti skeletons with Pb.
- Optimization of structure and composition of Ti-Pb composites (effect of Ti powder shape and size variation, effect of Pb content, effect of dispersion strengthening by carbide particle).

Task 4. Prototype Fabrication

The purpose of this task is to develop Ti-Pb anode design and technological tooling for prototype fabrication and to fabricate the prototypes for plant testing. Tooling for compaction and for infiltration will be designed and manufactured. Anode configurations will include Ti-Pb plate, Ti-Pb plate with a sheet titanium core, and Ti-Pb lattice with a rod titanium core. A copper hanger bar will be titanium-plated and attached to the anode by welding or by mechanical joint.
Activities will include:

- Engineering calculations and design.
- Fabrication of tools for manufacturing Ti -Pb anode prototypes.
- Fabrication of Ti-Pb plate anode prototype by infiltration.
- Fabrication of Ti-Pb plate anode prototype by consolidation of the mixture of Ti and Pb powders.
- Fabrication of Ti-Pb lattice anode prototype.

Task 6. Prototype Testing

The purpose of this task is to test the Ti-Pb prototype anodes under industrial operation conditions of the copper electrowinning and electrolytic manganese dioxide production. Tests will be conducted at the pilot plant of Noranda Corporation, which is one of the world's largest producers of Cu, Zn, Ni and other metals. Dr. George Houlachi at the Noranda Technology Center will supervise the testing. Activities will include:

- Testing anodes under the operation conditions of the copper electrowinning plant.
- Testing anodes under the operation conditions of EMD plant.

Task 8. Data Analysis

The purpose of this task is to analyze the results of the test and to use them for correction of anode composition and fabrication technology. Activities will include:

- Data analysis of testing anodes for copper electrowinning.
- Data analysis of testing anodes for EMD production.
- Correction and further optimization of the anode composition and technological conditions.

Task 10. Market Analysis/ Business Planning

This task will include the market analysis with electrowon metal and EMD producers to determine the market potential for Ti-Pb anodes. The additional information will include the art-to-market / time-to-market concept that will form the basis of a business plan for entering market, licensing, and joint ventures with producers.

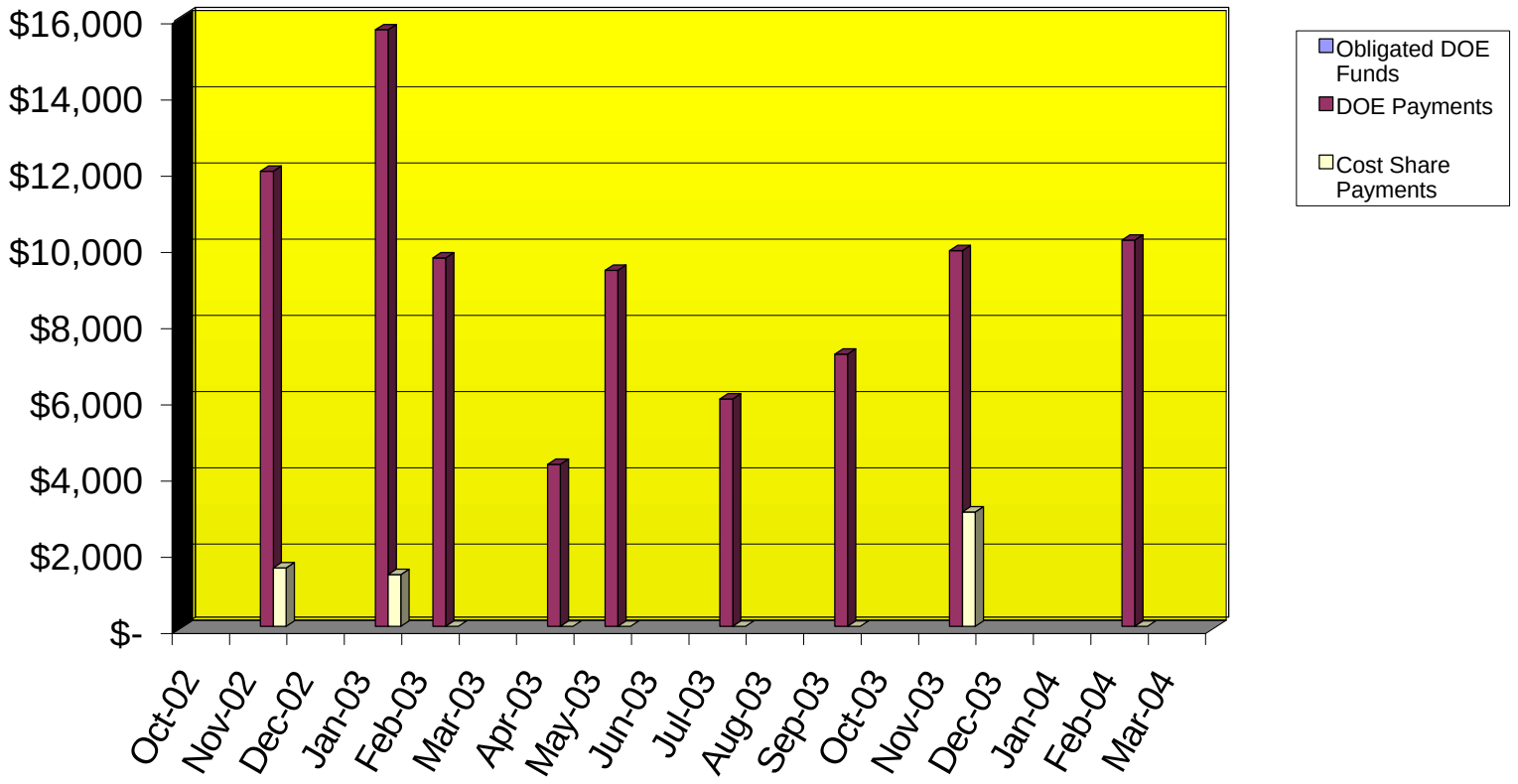
Tasks 1, 3, 5, 7, 9, 11, and 12. Project Management and Reporting

The PI will provide overall project management and reporting to meet contract requirements. The applicant will provide a Final Report containing the data from the experiments performed according to the above tasks along with analyses and conclusions based on this data.

Project Cost Performance in DOE Dollars for Fiscal Year 2003

DE-FG36-01GO11061 **Electrodes International, Inc.**

An Insoluble Titanium-Lead Anode for Sulfate Electrolytes



	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03
Obligated DOE Funds	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
DOE Payment	$0	$11,950	$0	$15,660	$9,670	$0	$4,250	$9,350	$0	$5,970	$0	$7,144
Cost Share Payment	$0	$1,540	$0	$1,360	$0	$0	$0	$0	$0	$0	$0	$0

	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04	PFY*	Cumulative
Obligated DOE Funds	$0	$0	$0	$0	$0	$0	$196,384	$196,384
DOE Payment	$0	$9,860	$0	$0	$10,140	$0	$72,390	$156,384
Cost Share Payment	$0	$3,000	$0	$0	$0	$0	$22,068	$27,968

Approved DOE Budget:	$196,384
Approved Cost Share Budget:	$36,132
Total Project Budget:	$232,516

* Prior Fiscal Years

Electrodes International, Inc. - 01GO11061

ID	Task Name	Start	Finish
1	Task 1: Submit Semi-Annual Report	Thu 11/1/01	Tue 4/30/02
2	Task 2: Optimization of Technology	Tue 2/5/02	Fri 5/31/02
3	Task 3: Submit Semi-Annual Report	Wed 5/1/02	Thu 10/31/02
4	Task 4: Prototype Fabrication	Wed 8/1/01	Wed 1/1/03
5	Task 5: Submit Semi-Annual Report	Fri 11/1/02	Wed 4/30/03
6	Task 6: Prototype Testing	Wed 1/1/03	Tue 8/31/04
7	Task 7: Submit Semi-Annual Report	Thu 5/1/03	Fri 10/31/03
8	Task 8: Data Analysis	Thu 8/1/02	Fri 7/30/04
9	Task 9: Submit Semi-Annual Report	Sat 11/1/03	Fri 4/30/04
10	Task 10: Market Analysis and Business Planning,	Wed 8/1/01	Wed 12/1/04